HYDROGEN PEROXIDE

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Walter C. Schumb

Professur of Inorganic Chemistry

Charles N. Satterfield

Associate Professor of Chemical Engineering

Ralph L. Wentworth

Industrial Liaison Officer Massachusetts Institute of Technology



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d on the basis Such action is tes capable of rogen peroxide rcial solutions d nature of a soly, too, that ed by a film of ce nature and t the reactive; s is the boiling he higher conofully distilled inhibits supern of Dorsey's pected to alter cleation could eous freezing case of hydroen ao distorted

thenomenon, aticular type-ofi s behavior of act flective in pre-Only seeding or percooling.

s estimated by value for water to water. The

Hatcher¹¹ to be 74 call/g. or 2516 cal./mole. Foley and Giguère' determined the heat of fusion to be 85.83 cal./g. or 2920 cal./mole, using an ice calorimeter and hydrogen peroxide derived from a 99.6% solution many times recrystallized. Both of these results are believed to have been affected by the presence of an uncertain proportion of water. The more precise experiments of Giguère, Liu, Dugdale and Morrison, made with an adiabatic calorimeter and hydrogen peroxide known to contain only 0.03 mole % water, provide the recommended value for the heat of fusion of hydrogen peroxide of \$87.84 cal./g. or 2087 ± 3 cal./mole. Specific heats for solid and liquid used in this work are detailed later. The accepted value for the heat of fusion of syster is 79.72 cal./g. or 1436.3 cal./mole.

Using this datum and the densities of solid and liquid, the slope, dp/dT, of the solid-liquid equilibrium line at the triple point for hydrogen peroxide, -0.42° C. (272.74°K.), may be calculated by the Clapeyron equation to be 148 atm./°K. The effect of pressure thus amounts to 0.007°K./atm. and the freezing point under atmospheric pressure is therefore -0.43° C. For water the value of dp/dT is -134 atm./°K. The value of the cryoscopic constant for hydrogen peroxide is similarly calculated to be 1.68°C./mole, compared to 1.86°C./mole for water.

Elquid-Vapor Phase Relationships for Hydrogen Peroxide

In the system water-hydrogen peroxide the liquid components are completely misciple and water is the more volatile to a considerable degree. The system shows negative deviations from Rucult's law; partial pressures of the components in the vapor over the liquid are less than those calculated for ideal solutions. Since there is a large difference in the vapor pressure of the pure components this deviation is not extreme enough to lead to the formation of areotropes; no vapor pressure minimum or boiling point formation exists.

The measurement of vapor pressures of hydrogen peroxide and its solutions is complicated by the decomposition that inevitably occurs on heating and concentrating a hydrogen peroxide solution which is not of the highest purity. At the same time the large differences in volatility make for relatively easy concentration in simple equipment of dilute products to the friengths of up to 30 wt. % or higher common in commerce. These facts undoubtedly retarded the undertaking of a precise determination of the propor-liquid equilibrium relationships of hydrogen peroxide; in the curly liferature only scattered boiling point data, reported incidentally in studies of concentration techniques, are available. ** ** More recent and extended when the configuid equilibrium data are given by Sidersky, ** and Uchidu, Ogawa, and Egerton, Emto, and Minkoff** for essentially anhydrous hydrogen per-

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ne condensate returned. All vapor passed over a cooling surface for regutoiler surrounded by the vapors arising from the primary boiler to which ating the amount of condensation into the inner boiler and through the quid in the inner boiler. By proper regulation of the cooling surface a lice between the hydrogen peroxide vapor and helium, which was in turn in contact with the mercury in the manometer. The desired temperature he partial pressure of exygen in the vapor space in this apparatus was then determined by the ratio of vaporization rate to decomposition rate, the thos acting to sweep the exygen into the helium reservoir. The large voline of this reservoir and the provision of means for periodic adjustment of pressure made it possible to reduce the effect of decomposition on system hmposition and temperatures were taken from a secondary or "inner" ng test. An alternative technique, which reduces the uncertainty due to chard, Kavanugh, and Ticknor (and those of the Japanese workers") were phriormed in such an apparatus. In this procedure there was a continuous was attained by regulating the pressure of helium admitted to the system, and the rate of vaporization was regulated by centrel of the heat input to on is a function only of temperature and quantity of liquid in the boiler, ressure to negligible proportions. Samples for the determination of liquid elecomposition, is to conduct the measurements in a dynamic system allowing continuous hoiling under controlled pressure. The experiments of Scatproduction of vapor and subsequent condensation and peturn of the condeneate to the boiler. Within the condenser there was established an interhe boiler. Assuming that the rate of production of oxygen by decomposi-The chief problem to be met in the measurement of the vapor pressure upd composition over hydrogen peroxide solutions is the shoidance or allownare for the change in composition or pressure which may be caused by decomposition. In most of the work cited the measurements have been curried out in a static system and some criterion was used for rejection of republis or else a means of extrapolation of a pressure-time curve was applied do take into account the effect of the small but important decomposition which occurred in the highly purified hydrogen peroxide samples undergo-

steady stat tained.

to be of gr taining stea the vapor p The orig presented in cause of fre lation of th

The meth

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105.

solutions.

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PHYSICAL PROPERTIES

gh and Ticknor. Their data ard, Kavanagh, and Ticknnce of vapor-liquid equilib he properties of hydrogen treatment will be discussed imposition. The agreemen tracy and best experiments arly at lower temperature

are presented that were no

the determination of liquid he primary boiler to which ns is the avoidance or allow um reservoir. The large vol o measurements have been ner boiler and through th ment of the vapor pressur on was used for rejection om a secondary or "inner r a cooling surface for regi e which may be caused b tion and return of the co re was established an inte in a dynamic system allo control of the heat input ntity of liquid in the boile to decomposition rate. ices the uncertainty due on of oxygen by decompo of decomposition on syste it important decompositi e. The experiments of Sc ure there was a continue l helium, which was in ti e in this apparatus was th ans for periodic adjusting on of the cooling surface peroxide samples under he Japanese workers⁷¹) w r. The desired temperati um admitted to the syste sure-time curve was appl

0.15161322

27.52 27.22 165.37 100.63

0.4580 0.6546 0.8418

0.1954

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8.8

0.5118

128.88 127.00

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0,3241 0.4800

> 76.00 75.00 75.00 75.00

0.2777

8.63 53.53 58.53 58.53

0.8572 0.9500

75.00

TAB	LB 16. V	TABLE 16, VATOR PRESSURE OF HTDEOGEN PEROXIDE-WATER SOLUTIONS,	HOGEN PEROXIDE-WATE	n Solutions,
		(FRUM SCATCHARD, DATAMAN, AND LICANOR-/	ANAUR, AND LICANOR /	-
Ä	Temp. (°C.)	Liquid Composition, mole fraction IIsOn	Total Vapor Pressure, mm. Hg at 0°C.	Vapor Composition, note fraction II,O ₂
	44.50	0.5140	27.47	0.1273
	90.09	0.0905	135.35	0.0054
	90.00	0.2036	114.82	0.0104
	80.00	0.2810	90.25	0.0307
	80.00	0.4075	70.21	0.0849
	90.00	0.5823	52.01	0.1757
	90.00	. 0.6831	30.70	0.2051
	8.8	0.8423	26.31	0.5000
	80.00	0.0010	10.43	0.8072
	75.00	0.0745	267.24	0.0030

leady state, i.e., constant level of liquid in the inner boiler, kould be at-

413.33

0.4985

106.00

0.9507

90.00 90.00 8.00

resented in Table 16. These authors believed the pressure measurements to be of greater accuracy than the vapor composition measurements, befairing steady state conditions. They have, accordingly, depended solely on the vapor pressure data for the calculation of vapor compositions, extrapoation of the data, and derivation of thermodynamic properties of the The original data obtained by Scatchard, Kavanagh and Ticknor are miss of fractionation in the boiler and experimental difficulties in main-

The method used by Scatchard, Kavanagh and Ticknor for smoothing

and extrapolating the vapor pressure data is as follows. It was desumed that the excess free energy of mixing per mole of solution could be represented by an equation of the form:

$$F_x^B = x_0(1-x_0)[B_0 + B_1(1-2x_0) + B_1(1-2x_0)^2]$$
 (11)

The excess free energy of mixing is defined as the excess or difference between the measured free energy and that defined for an ideal solution. The free energy is in turn related to the chemical potential or partial molal free energy and the activity coefficient by the equations,

$$\mu_e = \frac{\partial F}{\partial n_e} \tag{12}$$

$$F = \mu_i n_i + \mu_j n_j \tag{13}$$

$$\mu_a^E = RT \ln \gamma_c \tag{14}$$

The total vapor pressure of the solution is then given by the relation

$$P = \eta_{w_0} \cdot x_w \exp\left(\frac{1}{RT} \left[\mu_w^R - (\theta_w - V_w)(P - p_{w_0})\right]\right) + p_{h_0} (1 - x_w) \exp\left(\frac{1}{RT} \left[\mu_h^R - (\theta_h - V_h)(P - p_{h_0})\right]\right)$$
(15)

The first additive term is thus the partial pressure of water and the second that of hydrogen peroxide.

After multiplication of equation (11) by the term $(n_{\sigma} + n_{\star})$ to express F_{σ}^{μ} in terms of the total moles of solution and differentiation according to equation (12) there are obtained the following expressions for the excess chemical potentials of the components.

$$\mu_{x}^{x} = (1 - x_{x})^{3} [B_{0} + B_{1} (1 - 4x_{x}) + B_{2} (1 - 2x_{x}) (1 + 6x_{x})] \quad (16)$$

$$\mu_h^R = x_h^2 [B_0 + B_1(3 - 4x_p) + B_2(1 - 2x_p)(5 - 6x_m)]$$
 (17)

Equations (16) and (17) may now be substituted into equation (15) and equation (15) fitted to the measured vapor pressures. In fitting this equation to their data Seatchard, Kavanagh, and Ticknor used the following processive data Seatchard.

(1) The vapor pressure of water was calculated from the equation given by Keyes.

(2) The gas corrections for water were estimated by the method of Keyes, Smith, and Gerry." The corrections for hydrogen peroxide, after estimation of the critical constants, were obtained from the equation redommended for the critical constants.

(3) The vapor pressure of unhydrous hydrogen peroxide was obtained.

first by grapl cal extrapola the experime

(4) On the fitted to the of the metho with temper

The expreased relationship to process of evolvious refer linear form of extrapolating substance. This different fitted to the to and 450°C. The state of the total fitted to the total fitted fitte

log ps. (mm.

drogen perox

With equal equation, for stants B_a , B_i at various ten may be prepa were of a moclusion of der preparation of tions. Thus, f correction fac equation (15)

It was assumed that sould be represented

$$(1 - 2x_w)^2$$
 (11)

or an ideal solution. ntial or partial molal exeess or difference

in by the relation

$$(P-p_{h_0})$$

water and the second

 $(n_u + n_h)$ to express ntiation according to asions for the excess

$$(1 - 6x_{*})$$
 (16)

$$(5-6x_{*})$$

to equation (15) and n fitting this equation the following proce-

m the equation given

ion recommended for the method of Keyes xide, after estimation

roxide was obtained

first by graphical extrapolation of the data for solutions, then from analytical extrapolation of the successive approximations to the equation fitting

(4) On the basis of the three foregoing procedures the constants were the experimental vapor pressures.

fitted to the data at each temperature by a successive approximation form of the method of least squares. The constants obtained were then sphoothed with temperature, the following values being obtained:

$$B_0 = -752 + 0.97t = -1017 + 0.97T \tag{1}$$

$$B_1 = 85$$

$$B_1 = 13$$

This difference was found to be -1.5 × 10-. A four constant equation was Chainship was used within the range of experimental temperaturis in the divious reservence substance, water, deviates appreciably from the simple inear form over large temperature ranges. The Ramsey-Young mithod of Extrapolating vapor pressures was therefore used, with water as a reference Minstance. The vapor pressure, 17.7 mm. mercury, at 60°C. was used as the reference pressure and the vapor pressure, 78.4 mm. mercury, at 90°C. was used to obtain the difference of the slopes of the log p vs. 1/2 curves. fifted to the derived vapor pressure curve at the temperatures 75, 150, 300, neroxide vs. 1/T process of evaluating the constants, the $\log p$ to 1/T relationship for the and 450°C. The equation expressing the vapor pressure of anhydrans hywas obtained in the following manner. Although a linear log pro-The expression for the vapor pressure of unhydrous hydrogen drogen peroxide so obtained was:

$$\lim_{t \to 0} p_{b_{\bullet}}(m_{\rm m}) = 44.5760 - \frac{4025.3}{T} - 12.996 \log T + 0.0046055 T$$
 (21)

liftion of deviations from perfect gas behavior was not warranted in the onstant for this purpose, the terms of equation (15) containing the gas proction factor β were dropped. In terms of the activity coefficient, γ , equition (15) without the gas corrections becomes, by substitution of equa-Warious temperatures for all compositions of hydrogen peroxide splutions lay be prepared. It was believed that the corrections for gas imparfection fire of a magnitude comparable to experimental error and that the infiguration of an extrapolated table of vapor pressures and vapor composiefinition" for the vapor pressure of water, and the values for the confinits Ba., B1, and B2, a table of partial pressures and of vapor pressures With equation (21) for the vapor pressure of hydrogen peroxide | Keyes

$$P = p_{\mu} x_{\mu} \gamma_{\nu} + p_{\lambda_{\kappa}} (1 - x_{\nu}) \gamma_{\lambda} \tag{22}$$

 $\gamma_h = \exp\left(\frac{x_w^2}{RT}\right)$ Тавев 18. Уагог Values of the activity Total vapor pressure The data of Tables 17 * Extension of the tal un alternative method,74 It may be seen that t equations (22) and (2 PEROXIDE-WA (1 - 2) The vapor compositic over the temperature 0.002 0.003 0.003 0.004 0.004 0.005 0.006 0.007 0.007 0.008 0.000 0.010 0.011 0.012 0.013 exp Temp. (°C.) 9 2 2 2 2 2 2 3 88888 55 55 55 0.272 0.642 1.36 · 1.95 2.77 5.30 9.90 7.5 20.8 78.2 121 2 1'10. 6-hativity coefficients at 25°C, for squeous solutions of hydrogen poroxide 0.015 \$ 882540 25 12 28 25 13 28 25 13 28 25 13 28 22622 лаге 17. Тотац Vapor Равните (mm. Hg) ог Ихрасови PROXIDE-WATER SOLUTIONS (FROM SCATCHARD, KAVANADIL 7.8 2.2 120 180 1.30 2.62 3.71 5.14 0.55 260 380 552 562 767 1948 6 O.Z O.4 O.6 O.8 I MOLE FRACTION HYDROGEN PEROXIDE 1.21 0.856 2.53 1.83 5.00 3.66 6.90 5.00 9.41 6.99 10.0 37.8 70.0 61.8 124 97.8 180 160 280 220 331 474 686 910 1247 Mole Fraction Hydrogen Peroxide in Liquid 6 17.0 29.3 578 807 1106 1480 5 PHYSICAL PROPERTIES 9,6 1.66 3.42 6.68 0.17 12.4 22.2 37.0 62.0 100 155 236 346 1328 1738 1738 AND TICKNOR! 2 2.20 4.40 8.60 11.0 16.0 28.3 948 1168 1260 78.7 123 129 129 125 125 125 3 2.81 6.70 10.9 14.9 20.1 35.2 722 1008 1381 1860 2467 233 248 248 507 3 3.45 6.96 13.3 18.1 24.3 71.1 845 1176 1604 2163 2547 115 181 216 410 595 0.2 4.06 8.17 15.6 21.1 28.3 40.3 133 200 318 471 682 965 1330 1824 243 3223 ACTIVITY COEFFICIENT, Y. . 20 3 0 80 4 0 71 20 0 1 20 0 20 0 1 20 0 2225 25525 8 2 2 3 3 0 2 3 3 8 8 6 5 ន្ត

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Table 18. Vapor Composition (nole fraction H.O.) over Hydrogen Peroxide-Water Solutions, (from Scatchard, Kavanagh, and Tigenors)

Continue Capacida			_							
0.1 0.2 0.3 0.4 0.5 0.6 0.6 0.7 0.8 0.002 0.006 0.016 0.031 0.060 0.112 0.202 0.352 0.003 0.008 0.018 0.037 0.077 0.138 0.234 0.307 0.003 0.009 0.022 0.041 0.087 0.041 0.236 0.307 0.003 0.012 0.022 0.044 0.081 0.114 0.247 0.407 0.004 0.012 0.022 0.044 0.081 0.151 0.407 0.004 0.012 0.022 0.044 0.081 0.126 0.407 0.004 0.024 0.087 0.103 0.113 0.287 0.452 0.006 0.014 0.030 0.057 0.103 0.110 0.462 0.006 0.014 0.030 0.043 0.043 0.120 0.284 0.462 0.007 0.021 0.032 0.043				Mole Frac	tion Hydr	ogen Pero	ide in Liq	Pin		
0.002 0.006 0.015 0.031 0.000 0.112 0.202 0.352 0.003 0.008 0.018 0.037 0.070 0.128 0.234 0.381 0.003 0.009 0.020 0.041 0.077 0.138 0.238 0.307 0.003 0.010 0.022 0.044 0.081 0.151 0.247 0.407 0.004 0.012 0.022 0.046 0.185 0.151 0.287 0.407 0.004 0.012 0.022 0.046 0.185 0.181 0.287 0.407 0.005 0.014 0.023 0.067 0.103 0.176 0.387 0.462 0.006 0.017 0.036 0.089 0.120 0.307 0.463 0.007 0.019 0.043 0.080 0.120 0.304 0.510 0.008 0.021 0.041 0.041 0.144 0.231 0.510 0.009 0.022 0.043	j	1.0	0.2	0.3	4.0	0.5	9'0	6.7	83	6.9
0.003 0.008 0.018 0.037 0.029 0.128 0.224 0.381 0.003 0.009 0.020 0.041 0.077 0.138 0.288 0.307 0.003 0.010 0.022 0.041 0.031 0.144 0.247 0.407 0.004 0.012 0.022 0.046 0.081 0.141 0.247 0.407 0.004 0.012 0.022 0.046 0.085 0.151 0.256 0.417 0.005 0.014 0.022 0.064 0.085 0.103 0.287 0.435 0.006 0.014 0.033 0.083 0.111 0.187 0.287 0.465 0.006 0.017 0.036 0.083 0.112 0.100 0.465 0.007 0.010 0.040 0.074 0.126 0.210 0.405 0.007 0.010 0.043 0.080 0.134 0.231 0.569 0.007 0.021 0.043	0	0.002	0.006	0.015	0.031	090'0	0.112	0.203	0.352	0.600
0.003 0.009 0.020 0.041 0.077 0.138 0.238 0.307 0.003 0.010 0.022 0.044 0.081 0.144 0.247 0.407 0.003 0.010 0.022 0.046 0.185 0.181 0.217 0.407 0.004 0.012 0.022 0.026 0.181 0.272 0.417 0.005 0.014 0.026 0.064 0.103 0.176 0.287 0.462 0.006 0.017 0.036 0.067 0.103 0.176 0.287 0.462 0.007 0.017 0.036 0.068 0.120 0.106 0.463 0.007 0.019 0.040 0.074 0.128 0.210 0.320 0.463 0.007 0.019 0.041 0.080 0.136 0.21 0.324 0.568 0.008 0.021 0.047 0.080 0.136 0.21 0.364 0.510 0.008 0.022	2	0.003	0.00	0.018	0.037	0.00	0.128	0.22	0.381	0.626
0.003 0.010 0.022 0.044 0.081 0.144 0.247 0.407 0.003 0.010 0.022 0.046 0.161 0.256 0.417 0.004 0.012 0.022 0.046 0.161 0.256 0.417 0.005 0.014 0.022 0.064 0.103 0.272 0.455 0.006 0.014 0.030 0.067 0.103 0.176 0.287 0.462 0.006 0.017 0.036 0.063 0.120 0.109 0.462 0.007 0.019 0.040 0.044 0.128 0.210 0.482 0.007 0.021 0.043 0.089 0.129 0.30 0.495 0.008 0.022 0.047 0.086 0.136 0.221 0.305 0.50 0.009 0.022 0.047 0.086 0.144 0.231 0.51 0.51 0.010 0.022 0.051 0.096 0.144 0.231 <	8	0.003	0.00	0.020	0.041	0.077	0.138	0.238	0.307	0.650
0.003 0.010 0.023 0.046 0.056 0.151 0.256 0.417 0.004 0.012 0.026 0.062 0.064 0.163 0.272 0.435 0.005 0.014 0.026 0.067 0.103 0.176 0.287 0.463 0.006 0.015 0.036 0.068 0.120 0.106 0.463 0.006 0.017 0.036 0.068 0.120 0.100 0.463 0.007 0.021 0.043 0.089 0.128 0.210 0.320 0.468 0.008 0.022 0.043 0.089 0.138 0.221 0.322 0.408 0.008 0.023 0.047 0.086 0.134 0.231 0.510 0.510 0.009 0.022 0.047 0.086 0.144 0.231 0.510 0.510 0.010 0.027 0.064 0.097 0.064 0.060 0.241 0.251 0.540 0.012	8	0.003	0.010	0.022	170.0	0.081	0.1#	0.247	0.407	0.648
0.004 0.012 0.026 0.064 0.103 0.272 0.436 0.005 0.014 0.030 0.057 0.103 0.176 0.287 0.462 0.005 0.015 0.033 0.063 0.111 0.187 0.302 0.463 0.007 0.010 0.043 0.084 0.120 0.100 0.310 0.403 0.007 0.021 0.043 0.084 0.120 0.320 0.403 0.008 0.021 0.043 0.086 0.124 0.221 0.322 0.403 0.008 0.022 0.043 0.086 0.144 0.231 0.342 0.508 0.008 0.023 0.047 0.086 0.144 0.231 0.354 0.510 0.009 0.022 0.047 0.086 0.144 0.231 0.510 0.510 0.010 0.027 0.064 0.097 0.106 0.246 0.540 0.011 0.020 0.064	.	0.003	0.010	0.023	0.046	0.086	0.151	0.255	0.417	9.656
0.005 0.014 0.030 0.057 0.103 0.175 0.287 0.462 0.005 0.015 0.033 0.011 0.187 0.302 0.463 0.006 0.017 0.036 0.088 0.120 0.190 0.310 0.483 0.007 0.019 0.040 0.074 0.074 0.128 0.221 0.322 0.405 0.007 0.023 0.043 0.089 0.134 0.221 0.342 0.508 0.008 0.023 0.047 0.086 0.144 0.231 0.354 0.518 0.009 0.022 0.061 0.001 0.144 0.231 0.354 0.510 0.010 0.027 0.061 0.001 0.168 0.102 0.316 0.510 0.012 0.029 0.064 0.076 0.108 0.186 0.280 0.386 0.540 0.012 0.031 0.061 0.108 0.116 0.278 0.405 0.569	9	0.00	0.012	0.028	0.052	0.00	0.163	0.272	0.435	0.671
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0.007 0.010 0.040 0.074 0.128 0.210 0.320 0.405 0.007 0.021 0.043 0.080 0.136 0.221 0.342 0.508 0.008 0.022 0.047 0.085 0.144 0.231 0.354 0.508 0.009 0.025 0.067 0.001 0.152 0.241 0.354 0.510 0.010 0.027 0.064 0.007 0.160 0.251 0.376 0.540 0.011 0.020 0.068 0.102 0.168 0.280 0.386 0.540 0.012 0.031 0.061 0.108 0.176 0.280 0.386 0.540 0.012 0.033 0.066 0.113 0.182 0.280 0.386 0.540 0.012 0.033 0.066 0.113 0.182 0.280 0.386 0.540 0.013 0.033 0.066 0.113 0.182 0.273 0.405 0.566	2	9000	0.017	0.036	9.00	0.120	0.100	0.316	0.482	0.707
0.007 0.021 0.043 0.080 0.136 0.221 0.342 0.508 0.008 0.023 0.047 0.085 0.144 0.231 0.354 0.519 0.009 0.025 0.061 0.001 0.162 0.241 0.365 0.530 0.010 0.027 0.064 0.007 0.169 0.251 0.376 0.540 0.011 0.020 0.068 0.102 0.168 0.260 0.386 0.540 0.012 0.031 0.001 0.108 0.176 0.280 0.386 0.558 0.012 0.033 0.066 0.113 0.182 0.273 0.405 0.568	S	200.0	0.010	0.040	0.074	0.128	0.210	0.320	0.405	0.716
0.008 0.023 0.047 0.085 0.144 0.231 0.354 0.510 0.009 0.025 0.051 0.001 0.152 0.241 0.365 0.530 0.010 0.027 0.064 0.077 0.167 0.251 0.376 0.540 0.011 0.020 0.068 0.102 0.168 0.290 0.386 0.540 0.012 0.031 0.061 0.108 0.176 0.280 0.386 0.540 0.013 0.033 0.065 0.113 0.182 0.273 0.405 0.566	2	0.007	0.021	0.043	0.080	0.130	0.221	0.342	0.508	0.725
0.009 0.025 0.051 0.051 0.152 0.211 0.365 0.530 0.010 0.027 0.064 0.007 0.169 0.251 0.376 0.540 0.011 0.020 0.068 0.102 0.168 0.260 0.386 0.540 0.012 0.031 0.061 0.108 0.176 0.260 0.386 0.558 0.013 0.033 0.065 0.113 0.182 0.273 0.405 0.568	100	0.008	0.023	0.047	0.085	0.144	0.231	0.354		0.733
0.009 0.025 0.051 0.001 0.152 0.211 0.305 0.530 0.010 0.027 0.004 0.007 0.100 0.251 0.376 0.540 0.011 0.020 0.008 0.102 0.108 0.200 0.200 0.008 0.102 0.108 0.200 0.200 0.051 0.051 0.051 0.001 0.001 0.001 0.001 0.108 0.108 0.108 0.200 0.200 0.500 0.500 0.050 0.013 0.003 0.013 0.103 0.103 0.200 0.500		·								
0.010 0.027 0.064 0.067 0.160 0.251 0.376 0.540 0.011 0.020 0.068 0.102 0.168 0.260 0.386 0.540 0.012 0.031 0.061 0.108 0.176 0.280 0.390 0.540 0.013 0.033 0.065 0.113 0.182 0.278 0.405 0.566	110	0000	0.025	0.001	0.001	0.152	0.241	0.365	0.530	0.730
0.011 0.029 0.058 0.102 0.168 0.260 0.386 0.549 0.012 0.031 0.061 0.108 0.176 0.289 0.306 0.558 0.058 0.013 0.033 0.065 0.113 0.182 0.278 0.405 0.566	120	0.010	0.027	0.05	0.007	0.160	0.251	0.376	0.540	0.747
0.012 0.031 0.061 0.108 0.175 0.269 0.306 0.568 0.058 0.058	130	0 011	0.020	0.058	0.102	0.168	0.280	0.386	0.540	0.753
0.013 0.033 0.065 0.113 0.182 0.278 0.405 0.566	140	0.012	0.031	0.061	0.108	0.175	0.280	0.300	0.558	0.758
	160	0.013	0.033	0.065	0.113	0.182		0.405	0.566	0.763
		_		_						-

hydrogon peroxide

[YDROGEN LVANAGII, fingy be seen that the activity coefficients are expressed as follows:

$$\exp\left(\frac{(1-x_{\rm u})^2}{RT}\left[B_{\rm b}+B_{\rm l}(1-4x_{\rm u})+B_{\rm l}(1-2x_{\rm u})(1-6x_{\rm u})\right]\right) (23)$$

$$\frac{x_0}{NT_0} = \exp\left(\frac{x_0^2}{RT} \left[B_0 + B_1(3 - 4x_0) + B_2(1 - 2x_0)(5 - 6x_0) \right] \right) \quad (24)$$

fitting of the activity coefficients at 25°C, have been plotted in Figure 6 May spor compositions may be calculated from the relation:

3.77 7.14 12.0

5.14 9.55 17.0

1.80 2.60

2

6.0

$$y_{\lambda} = \frac{p_{h_0} x_{h} \gamma_{h}}{P} = \frac{p_{h_0} x_{h} \gamma_{h}}{(p_{h_0} x_{h} \gamma_{h}) + (p_{h_0} x_{h} \gamma_{h})}$$
(25)

Collivator pressures and vapor compositions calculated by the use of this control of the compositions of the control of t

280 280, 387, 546

The state of the tabulated data may be accomplished with these equations or many be mad be used.